National Trust

Sustainable technology case study

- 48 solar panels
- 12kW PV system
- bespoke PV array
- not visible from the ground

Photovoltaics

Photovoltaic installation on the castle roof

February 2012

Background

In 2010, exploring the idea of installing solar panels on the leaded roof areas of the castle started. The goal of the project was to contribute towards the Trust's 'Grow your own energy' strategy and to assist in reducing utility costs – Lindisfarne Castle had been consuming 77kW hours of energy per annum.

The installation of a 12kW solar photovoltaic array on the main roof of the castle would support Yorkshire & North East's energy KPI, the Trust's 50% reduction in the use of fossil fuels and also improve general operational efficiencies at the castle.

Through a combination of revenue and cost savings associated with solar PV systems, the proposed installation should make for a payback period of 14 years and provide a full return on investment and make a contribution of an estimated 12% of the property's annual energy.

In June 2011 the project was incorporated into Yorkshire & North East's wider solar PV programme. It represented part of the property and regions contribution to the Trust's ambition to reduce energy consumption.

The project

Under the Government's Feed in Tariff (FiT) scheme, photovoltaics were the only and obvious option for use at Lindisfarne Castle.

The Feed in Tariff was put in place to support the initial investment of installing this technology and to provide an on-going revenue stream – the FiT payment being guaranteed for a period of 25 years.

At the time of this project the FiT rates as set by the Government were applicable on all PV installations producing electricity before the end of March 2012. The FiT to the end of March 2012 was 43.3p per kWh.

Whilst not confirmed at the time, it was suggested that post-March 2012 the FiT would be reduced by around 12%. Therefore there was some urgency to install as many solutions as possible before this deadline in order to capitalise on the FiT over the 25 year term of the payment scheme.

The Property Manager and Energy Advisor engaged with a number of potential suppliers to undertake a feasibility study of the proposed installation area and to develop an installation design.

The original proposal was for 10kW on the two rooftops. However a revised design managed to allow for a 12kW installation on just one rooftop. Each panel is 245w each.

The design was submitted with a Listed Building Consent application and Planning Permission was granted with the condition that any installation did not protrude above the parapet walls.

Following a formal tender managed by the region's Procurement Business Partner, a well-established research & development and engineering company within the solar market were appointed as the supplier for the project. They partnered with a regional electrical installation company to undertake the installation. These are well known to the region and have an excellent track record of working within the region's historic buildings.

The engineering company was invited to undertake a full site survey and to devise a design to meet the requirements of the Planning consent, ensuring that the integrity of the historic building was protected.

Right **Lindisfarne Castle in context**

Far right **Planning Permission stated that the PV panels should not be visible**

Design

The proposed PV array solution was designed by the engineering company in collaboration with the region's Consultancy.

The engineering company have utilised their expertise in the solar market to devise a 12kW solar array. The system kW size is three times that of the installation at Dunster Castle.

Lindisfarne Castle's complex roof layout presented a unique set of challenges. The design had to take into account the aesthetics and historical importance of the building to ensure that there would be no weight or direct contact of the panels or frame on the roof itself.

To combat uncertain shade levels throughout the day and to maximise the system output, the engineering company developed a panel link and inverter set-up. Each panel was fitted with a monitoring device so that individual modules can be switched off when they become shaded by the parapet or chimney. Individual panels can also switch off from the circuit if too much of their surface gets covered in bird droppings. This system allows the remaining panels to continue functioning at full capacity.

The PV modules are Monocrystalline 245w units, manufactured by one of the primary suppliers of solar photovoltaic panels. These units have a proven record of performance, durability and reliability.

Small holes were drilled into the masonry to accommodate the wall fixings. These were then fixed with resin.

The brackets holding the frame and their resin method of fixing were presented to and approved by the Architectural Panel. Should the system need to be taken out the fixings can be cut flush back to the walls.

The supporting framework was designed to be lightweight, yet extremely robust and to limit the impact upon the structure of the building – all fixings were discussed with the regional Curator and are fully reversible.

The design utilises a light weight 'uni-strut', hot dipped, galvanised frame system which will minimise the load on the castle walls. The galvanised system will suit the potentially corrosive environment at the castle. Bespoke wall brackets were also designed to minimise weight load issues.

The framework floats over the lead roof such that it is uncompromised; however in a number of places a small 'leg' drops from the framework and rests on secondary pads placed on the lead to provide support in extreme wind conditions. These legs do not place weight on the roof and the secondary pads will ensure no degradation of the lead surface occurs.

The custom lightweight frame sits immediately above the East Bedroom of the castle.

The solar equipment, framework and panels were brought to roof level via the property stairs – there was no requirement for scaffold to be erected.

Above left **Bespoke wall brackets were designed to minimise the frame's overall weight load**

Above right **One of the small 'legs' to support the framework during extreme wind conditions**

Cost

Total: Around £45,000

Carbon reduction

- The system is expected to save 5.2 tonnes of carbon from being emitted every year.
- Payback is set for around nine years – due to attracting the higher rate of Feed in Tariff.

Review

Performance

Lindisfarne Castle has two electricity meters – one for general power and one for Economy 7. The PV installation is connected to the general power supply.

The castle contains around 10-12 storage heaters. Some of the storage heaters have a combined 'on-peak' convector heater.

As each panel has its own inverter, it is possible to identify if one of them has a problem, as opposed to the more usual one in a group of six.

The energy generation from the solar panels is expected to be around 8,592kWh per annum. The system appears to be performing better than originally expected. This is probably due to the installation of individual inverters, which allows for selected panels to switch off if they are shaded, whilst the others continue to generate energy.

Energy generation

Annual energy contribution for 2012-13: 7,883 kWh or 7.6% of Lindisfarne Castle's energy due to a gloomy summer.

The PVs at Lindisfarne Castle should contribute approximately 10 or 12% of the property's annual electricity requirement. The installation could produce up to 10,000kWh of electricity each year.

Electrical savings as at end of May 2013: 10,619 kWh.

Projected annual saving: £1,135.20.
There will be a saving of 11p if the energy is used on site or a 3 pence profit if it is sold back to the Grid.

Maintenance

The parapet walls are very low in places and this presents issues with cleaning. A contractor may be used for washing the panels.

There have not been any problems with salt as yet.

Above left **The parapet walls are very low in places**

Above right **One of the supporting 'legs' sitting on a secondary pad so as not to damage the lead roof**

Lessons learnt

The project took more than two years to complete due to various staff changes.

Although Planning Permission had been granted, one of the conditions had been that the PV panels should not be visible from the ground. This condition was not feasible in the original plans, therefore a re-design was required. This was then presented back to the Planners to ensure that it met with their conditions.

The installation contractors were very good. They were accommodated on the island to keep costs down; they were conscientious – not taking any risks with health and safety.

Review

Lessons learnt

The project had to be accelerated to meet the higher rate of Feed in Tariff before it was reduced to a lower level.

The property has had less involvement with the engineering company since the changes to the Feed in Tariff.

The team at Lindisfarne wanted to make an installation that was much lighter than the solution adopted at Dunster Castle. This was made possible by utilising the uni-strut and bracket system.

The system was using the Economy 7 electric meters initially, which meant that the property was not using the energy it generated at first. This was due to project timescales. The meter has been changed over to make use of the energy being produced on site.

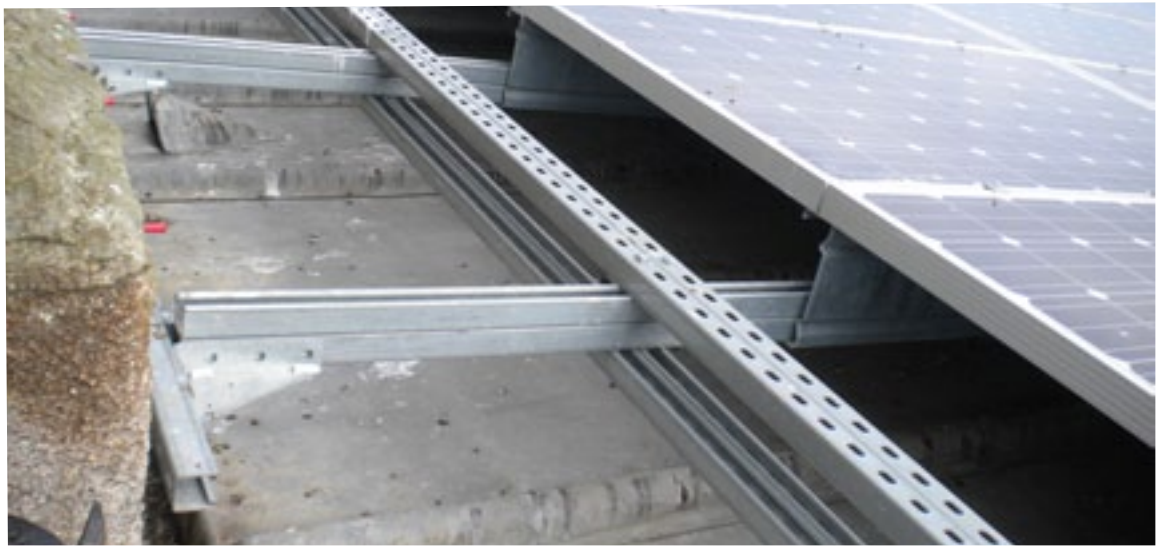
Future plans

It is only really possible to make cultural changes at the castle – although the property may consider changing the storage heaters if funding was available for a more discrete system.

Another option would be to try and improve the secondary glazing, with windows that close more effectively, plus change the curtains for more heavy-weight alternatives.

These are items that have been identified to improve in the long term.

Above **The installation stops short of the gap in the parapet wall to prevent views of it from below**



Right **The PV array is elevated above the lead roof**

Review

Recommendations

Specify in long term maintenance at the beginning of the project.

Research fire risk for electrical installations. It is important to get the right installer when working with high voltage installations. At Lindisfarne this was ensured through the tendering process.

Consider the long term management of the system including any health and safety risks.

Remember to reflect annual maintenance costs into the operating budgets (electrical testing and cleaning routines).

Ensure a comprehensive system handover to ensure that property staff are confident with how the system works and how to interpret the data that it creates. Work on an assumption of zero knowledge of PV systems.

Above left **Lindisfarne Castle in the distance**

Above right **Views from the roof of the castle**

Contact

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